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POWER QUALITY AND VOLTAGE STABILITY OF TRANSMISSION LINE USING STATCOM AND SSSC

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ABSTRACT

Last two decades, power demand has increased substantially while the expansion of power generation and transmission has been severely limited due to limited resources and environmental conditions. some transmission lines are heavily loaded and the system stability becomes a poor. Steady state and transient problems in a power system have undesirable consequences on the system. The main objective of this paper is a comparative investigate in enhancement of voltage stability via static synchronous series compensator (SSSC) and static synchronous shunt compensator (STATCOM) externally controlled by a POD controller. The new designed P.O.D controller is very efficient for voltage stability and power system stability under transient conditions. This paper discusses and demonstrates the comparison between the STATCOM with P.O.D controller and SSSC with P.O.D controller, to power system for effectively regulating system voltage for different types of faulted condition. Simulation results shows that STATCOM with POD controller is more effective to enhance the voltage stability and power system stability and increase transmission capacity in a power system.

KEYWORDS: FACTS, SSSC, STATCOM, POD Controller

INTRODUCTION

Generation, Transmission, distribution & consumption are main fields of power system. Power system needs flexibility, reliable operation, accuracy & fast response of the system. FACTS are power electronic based circuit used for changing voltage, impendence of line & phase angle at particular point of the system. Voltage source converters also known FACTS controllers. FACTS family includes STATCOM and SSSC. SSSC and STATCOM can be used damped the oscillations.

SSSC

SSSC is one of the main fact equipment. VSC and a transformer is joined in series with the line.The SSSC injects a voltage of adjustable magnitude in quadrature with the line current, thereby emulating an inductive or capacitive reactance. Active and reactive power in the transmission system is interchange by SSSC. Due to contingency or non- linear loads reactive power should be disturbed. So our main aim stable the power system. Power oscillation can be damped by using SSSC in power grid a 3-phase fault.

STATCOM

STATCOM is very important fact device. it also depend upon voltage source converter. the system voltage can be absorbed or generating by using Static synchronous shunt compensator. poor power factor and poor voltage regulation are two reasons to use STATCOM. It also use for voltage stability. STATCOM provides better power oscillation damping than SVC.

POD Controller

Power oscillation damping controller is installed on the static synchronous series compensator and static synchronous shunt compensator to improve the system dynamic behavior. The variations in the power system should be damped. Pod controller can be used handle nonlinear loads Its operation should be faster by using POD controller and improve the reactive power of the power system. Active power measurement can be measured POD controller. High pass filter should be wash out. POD controller is generally a low pass filter, a generally gain, a leading compensator

SIMULATION MODEL OF TEST SYSTEM DESCRIPTION

The grid consists of two primary substations and and one main load center at bus B3. There are six machines 350 MVA and total power generation substation is2100 MVA and other one has four machines of 350 MVA total generation capacity 1400 MVA. The dynamic load value is 2200MW. The active and reactive power is absorbed by the system voltage. The lines L1, L2 are joined to substation M1.Transmission line.L1 is 280 km and transmission line L2 is divided into two parts 150 km in order simulation of three phase fault. The generation substation M2 is also joined to 50 km line(L3). The static synchronous series compensator is placed at B1, is series with the transmission line L1. It has a rating of 100MVA.and is capable of injecting upto 10 percent nominal voltage.

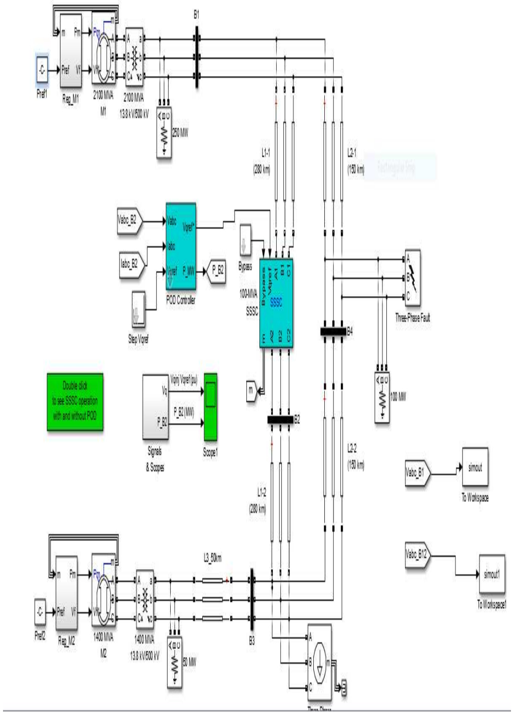

Figure 1: Model of SSSC

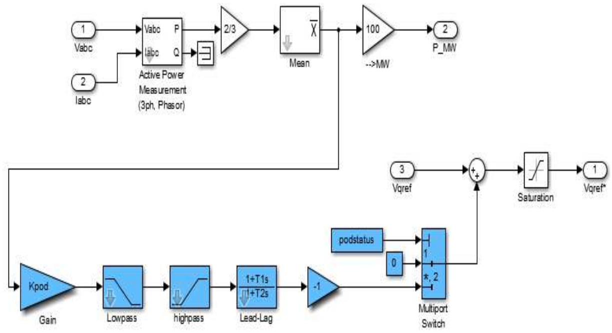

Figure 2: Controller of SSSC

The SSSC block is designed using phasor model and the model is shown below

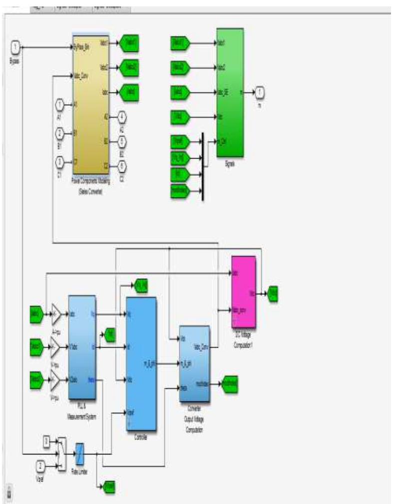

Figure 3: Phasor Model

Similarly the same system is designed using a STATCOM and three phase fault is introduced in the line. It canbe considered as a synchronous voltage source as it can inject an almost sinusoidal voltage of variable and controllable amplitude and phase angle in series with a transmission line.

The injected voltage is almost in quadrature with the line current. The STATCOM model is shown below

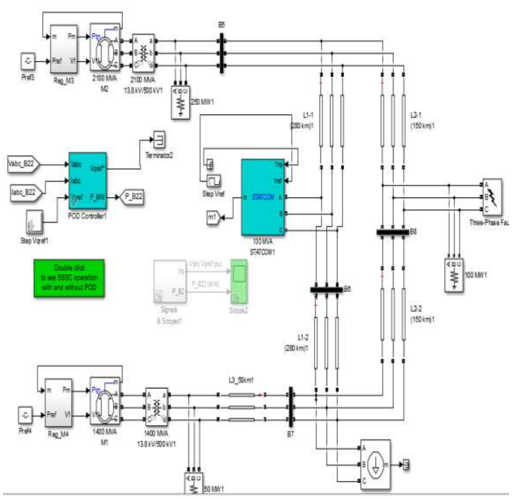

Figure 4: STATCOM is Connected in Transmission Line with Same Parameters as SSSC

The STATCOM is designed as below

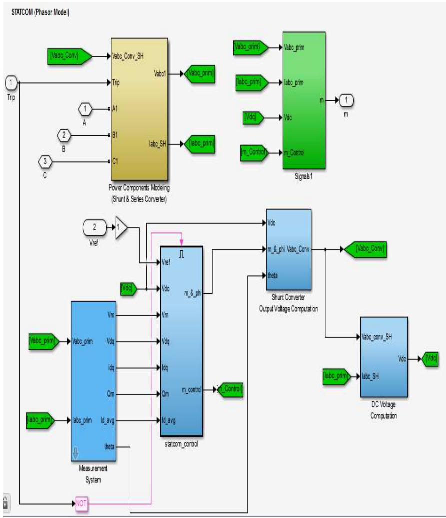

Figure 5: Phasor Model of STATCOM

The model is controlled using controller as shown below

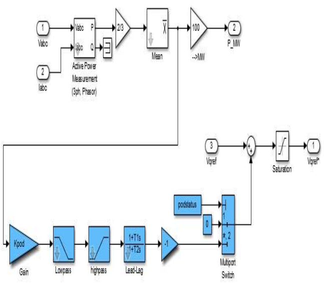

Figure 6: Working of Controller

SIMULATION RESULTS AND DISCUSSIONS

Theresults of simulation are discussed as follows:-

SSSC Dynamic Response

We will first verify the dynamic response of our system. Open the step V_{qref} block. The reference voltage should be modified. At starting at equal to 0 p.u; at t=2 sec, SSSC is inductive when V_{qref} is equal to -0.08pu. SSSC is capacitive when V_{qref} 0.08pu. During simulation fault breaker will not operate.

Run the simulation scope1. Static synchronous series compensator is used to determine the injected voltage V_{qref}. The active power (P_B2) on the transmission line on L1 is measured in second graph measured by bus B2 The power flow changes from 575 to 750 MW. V_{qref} should varies to avoid the oscillations we see transmitted power. To see the control parameters the max rate of change for 3 to 0.05. the power oscillation on the active power should be small.

All simulations are done in MATLAB R2015 b on a 2.7 GHz processor based computer with 8 GB RAM and 1TB hard disk. The power system is designed as discussed.

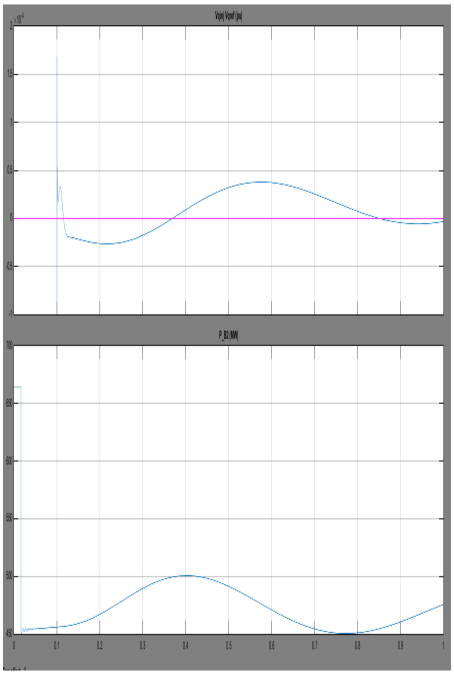

Figure 7: Voltage Injecting and Active Power Bus at B1

The given waveform is simulation results of Vq injected voltage the injected voltage is varying from 0.25 *10^-4 to -0.25*10^-4. The active power in bus B2 Starting from 670 MW (Approx.) and then down to 450 MW to 500MW varying sinsuodally in figure 7.

In figure 8 The given four waveform shows that Vq injected voltage Vqref(pu). The second waveform direct current axis(pu) starting from 1.5 then increasing sharply 4.the varying 4 to 4.5 varying continuously The third waveform shows the modulation index. The fourth waveform gives the active power of the system.

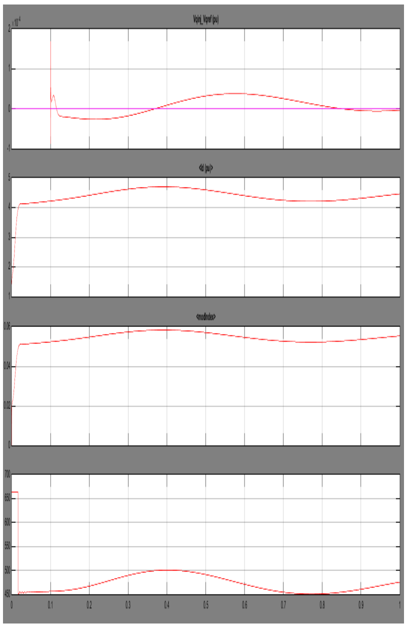

Figure 8: Injecting Voltage Curve 1, Curve 2 Represents Direct Axis Current, Curve3 Represents Magnitude of Bus 1,2,3,4 & Curve 4 Represents Reactive Power of Bus 1,2,3,4

The waveforms shows the magnitude bus voltage B1, B2, B3, B4 close to 1 p.u. The second waveform shows the active power of the system of Bus B1, B2, B3, B4. is measured in MW. The third waveform shows that the reactive power of the bus B1, B2, B3 & B4 IS measured in measured in MVAR.

In the given figure 9 voltage is busB1, B2 B3, B4 nearly equal 1 p.u. The second curve shows the active power of Bus B1,B2, B3, B4 gives the values of 1200mw,1000mw,600mw,0mw (approx) the third curve represents the reactive power of Bus B1, B2, B3, B4 gives the values of 100 mvar,0mvar,-250mvar,-500mvar (approx.)

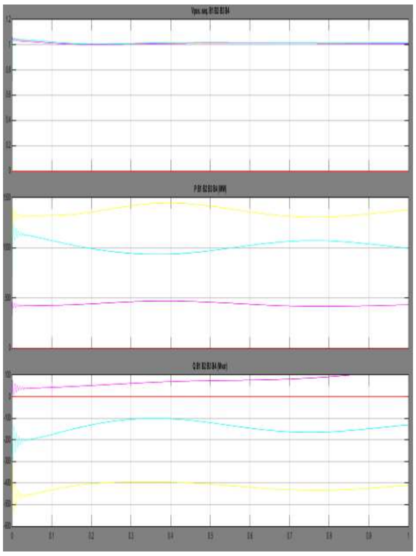

Figure 9: Shows Voltage, Active Power, Reactive Power of Bus B1, B2, B3. B4

CONCLUSIONS AND FUTURE SCOPE

The power system is designed with synchronous generators connected using transmission lines. The SSSC is applied in series while the STATCOM is applied in shunt. The results are analysed and it is found that STATCOM has better transient response than SSSC in case of fault. Also in terms of voltage magnitutde the STATCOM is being outperformed by SSSC controlled transmission line. This is due to the series nature of the SSSC. In future other controllers can be applied on the same power system and also various techniques can be applied for controlling those devices. The performance can be evaluated for a grid.

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